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Review Article

Chemical and pharmacological aspects of *Limnophila geoffrayi*: An update

Dilip Gorai[1,*], Rajiv Roy[1], Atasi Sarkar[2] and Dipak Kumar Roy[3]

[1]Department of Chemistry, Kulti College, Kulti, Burdwan-713343, West Bengal, India
[2]Department of Zoology, Kapastikuri S.S.K. Vidyapeeth, Sitapur-731235, Birbhum, West Bengal, India
[3]Kalui Charitable Dispensary, Jilla Parisad Burdwan-713145, West Bengal, India

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ABSTRACT

The present work offers a review addressing the chemistry and pharmacology of *Limnophila geoffrayi* Bonati (belonging to Scrophulariaceae family) regarded as one of the most significant plant species in traditional system of medicine. The plant is used traditionally as an antipyretic, expectorant, lactogogue and to prepare a decoction as antidote for detoxification of poisons. Few phytochemical studies have been done so far on this plant. Thirteen chemical constituents have been reported from this plant and crude plant extracts as well as pure phytochemicals are reported to exhibit antimicrobial and antioxidant activities. Exhaustive research regarding isolation of more phytochemicals and pharmacology study on this medicinal plant is still necessary so as to explore the plant regarding its medicinal importance. Therefore, the aim of this review is to boost up present day researchers in this direction to undertake further investigation on this plant to find new '*lead molecule*' in the ongoing drug discovery programme. The present review covers literature up to August 2014.

Keywords: *Limnophila geoffrayi*, Scrophulariaceae, Chemical constituents, Biological activity

INTRODUCTION

Limnophila geoffrayi Bonati (Scrophulariaceae) is used as a vegetative ingredient in a traditional curry in northeastern Thailand [1]. In spite of a relatively restricted distribution, the species appears to be widespread and fairly abundant [2]. In combination with its ability to exploit anthropogenic habitats, it is unlikely to be threatened with extinction in the short term; it is therefore assessed as Least Concern [2]. The species occurs in Cambodia, Lao PDR, Thailand and Viet Nam [3-6]. The species grows in the margins of ponds, marshes and rice fields, as well as in floating mats of vegetation on large open water bodies such as the Tonle Sap Lake in Cambodia [2]. This plant species is used traditionally as an antipyretic, expectorant and lactogogue [1, 7]. According to the northeastern Thai folkloric medicine, the dried whole plants that have been kept for one year is used to prepare a decoction as antidote for detoxification of poisons [1,8]. Few phytochemical studies have been done so far on this plant. Thirteen chemical constituents of flavonoids and terpenoids classes have been isolated from this plant and crude plant extracts as well as pure phytochemicals are reported to exhibit antimicrobial and antioxidant activities. Exhaustive research regarding isolation of more phytochemicals and pharmacology study on this medicinal plant is still necessary so as to explore the plant regarding its medicinal importance. The aim of this review is to boost up present day researchers in this direction to undertake further investigation in more systematic way on this plant to discover new '*lead molecule*' in the ongoing drug discovery programme which will be helpful for mankind.

The taxonomical classification of *Limnophila geoffrayi* is shown below:

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Scrophulariales
Family	Scrophulariaceae
Genus	*Limnophila*
Species	*L. geoffrayi*
Binomial name	*Limnophila geoffrayi* Bonati

***Corresponding Author Address:** Dr. Dilip Gorai, Department of Chemistry, Kulti College, Kulti, Burdwan-713343, West Bengal, India; E-mail: Dgorai2005@yahoo.co.in*

A photocopy of *Limnophila geoffrayi* (family: Scrophulariaceae)

Materials and Methods

The chemical constituents isolated and identified from *Limnophila geoffrayi*, pharmacological activities exhibited by the isolated compounds as well as by the crude plant extracts were searched across the Medline (National Library of Medicine) and Science Direct databases. The data were updated in August 2014, using the search-terms Limnophila geoffrayi, chemical constituents, biological activities, pharmacological activities or properties of Limnophila geoffrayi as keywords. In addition, the reference lists of all papers identified were reviewed.

Phytochemical study: Few phytochemical studies on this medicinal plant have been reported. Thirteen phytochemicals (Structure No. **1-13**) of flavonoids and terpenoids classes have been isolated. These are listed in **Table-1** and their structures are shown in **Figure-1**.

Table-1: List of Chemical constituents isolated from *L. geoffrayi*

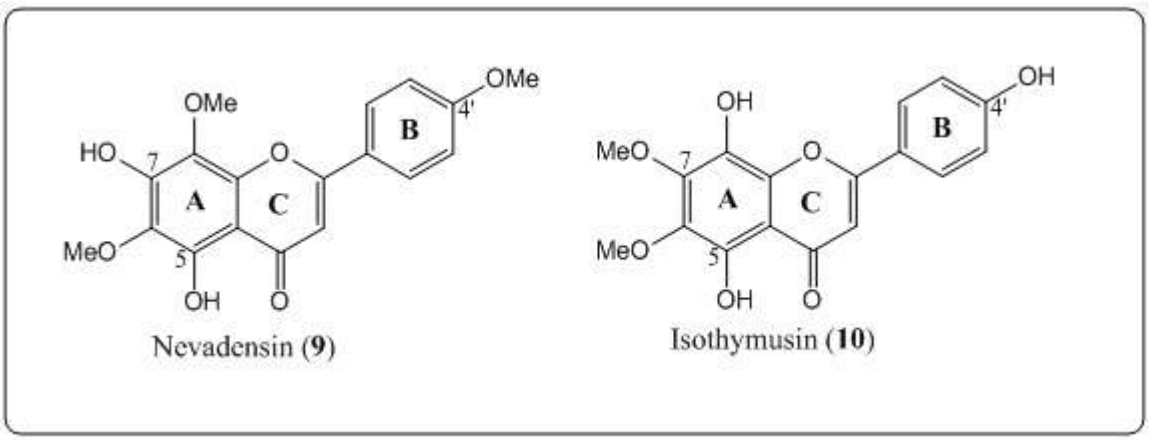
Chemical constituent (Structure No.)	Plant parts	References
Limnophilaspiroketone (**1**)	Aerial parts	9
Betulinic acid (**2**)	Aerial parts	9
4-*Epi*-hederagenin (**3**)	Aerial parts	9
3-Farnesyl-4-hydroxybenzoic acid (**4**)	Aerial parts	9
Gardenin B (**5**)	Aerial parts	9
6*β*-Hydroxyoleanolic acid (**6**)	Aerial parts	9
Rotungenic acid (**7**)	Aerial parts	9
Uncaric acid (**8**)	Aerial parts	9
Nevadensin (**9**)	Aerial parts	1, 9
Isothymusin (**10**)	Aerial parts	1, 9
d-Pulegone (**11**)	Essential oil	10
Limonene (**12**)	Essential oil	10
Perillaldehyde (**13**)	Essential oil	10

Biological activity/Pharmacological study: Crude plant extracts as well as pure isolated phytochemicals exhibited different biological activities as discussed below;

Antimicrobial activity: Chloroform extract of the aerial parts of *L. geoffrayi* was found to possess antimycobacterial activities [1]. Nevadensin **(9)** and isothymusin (**10**), isolated from the chloroform extract of the aerial parts of the plant, were reported to exhibit growth-inhibitory activity against *mycobacterium tuberculosis* H 37Ra with equal MIC value of 200 µg/mL [1]; however, the efficacy is relatively lower than those of the standard drugs (used during the experiment) rifampicin (MIC 0.003-0.0047 µg/mL), isoniazid (MIC 0.025-0.05 µg/mL) and kanamycin sulphate (MIC 1.25-2.5 µg/mL). Nevadensin **(9)**, isolated from another *Limnophila* plant source, was also found to be effective (MIC values: 100 µg/mL for nevadensin; 10µg/mL for streptomycin used as standard) against the H 37RV strain of *M. tuberculosis* as reported by Reddy *et al.* [11]. The investigators reported that the compound shows no toxicity up to 600 µg/Kg orally in acute toxicity studies.

The essential oil of the plant possessed high antimicrobial activity against microorganisms encountered normally in contaminated cosmetic products, using the agar- and broth-dilution methods, with minimum inhibitory concentrations ranging from 0.03 to 0.2% per unit volume (v/v) [10]. Strong insecticidal activity as a fumigant was also observed at an oil dose of 5µl/disc, with a 94% mortality. Perillaldehyde (**13**) was the most active compound among the main components of these essential oils [10]. Methanol extract of the plant is found to be active [12] against *Burkholderia pseudomallei* — an important pathogen in tropical regions of Northern Australia and South-East Asia, including Thailand which causes melioidosis [13]. The extract at a concentration of 5 mg/disc is found to inhibit the zone of growth of two strains of the pathogen—A2 and G207 with 8 mm for both cases measured by disc diffusion method *i.e.* the extract showed very weak MIC (Minimum inhibitory concentration) and MBC (Minimal bactericidal concentration) values (>128 mg/mL) against the experimental pathogenic strains [12].

Antioxidant activity: Suksamrarn *et al.* [1] reported significant antioxidant activity of chloroform extract of aerial part of *L. geoffrayi.* Bioassay-guided fractionation of the extract led to the isolation of two pentaoxygenated flavones — nevadensin (**9**) and isothymusin (**10**), of which only the latter exhibited antioxidant activity against the radical scavenging ability of 1,1-diphenyl-2-picrylhydrazyl (DPPH) with the IC_{50} value of 7.7 µg/mL. The efficacy is almost comparative with the standard antioxidant compound 2,6-di-(tert-butyl)-4-methylphenol (BHT, IC_{50} =5.7 µg/mL) [1]. It is interesting to note that isothymusin **(10)** while shows strong antioxidant property, nevadensin (**9**) can't — this contrasting difference in the behaviour may be explained on the basis of structure/activity relationship. The free 4'-hydroxy group in isothymusin **(10)** molecule exerts delocalization with the 4-keto group after the 4'-hydrogen being abstracted. The *p*-hydroquinone nature of the A-ring possibly also contributes to the relatively high antioxidant activity of the compound. It should also be noted that the free 7-hydroxyl group of nevadensin does not exert any radical scavenging activity by similar mechanism to that of the free 4'-hydroxyl group as observed in case of isothymusin; one possible cause may be the steric hindrance developed due to the two adjacent methoxyls, although such effect is not observed in case of BHT [1].



CONCLUSIONS

The present article deals with an up-to-date review on the chemistry and pharmacology of *Limnophila geoffrayi*, a useful medicinal plant from Scrophulariaceae family finding applications in traditional system of medicine. The plant is used traditionally as an antipyretic, expectorant, lactogogue and to prepare a decoction as antidote for detoxification of poisons. The isolated phytochemicals as well as different extracts exhibited significant biological activities like antimicrobial and antioxidant activities. Exhaustive research regarding isolation of more phytochemicals and pharmacology study on this medicinal plant is still necessary so as to explore the plant regarding its medicinal importance. Therefore, the aim of this review is to boost up present day researchers in this direction to undertake further investigations on this plant and we do anticipate that this plant will be much effective in drug development programme in near future.

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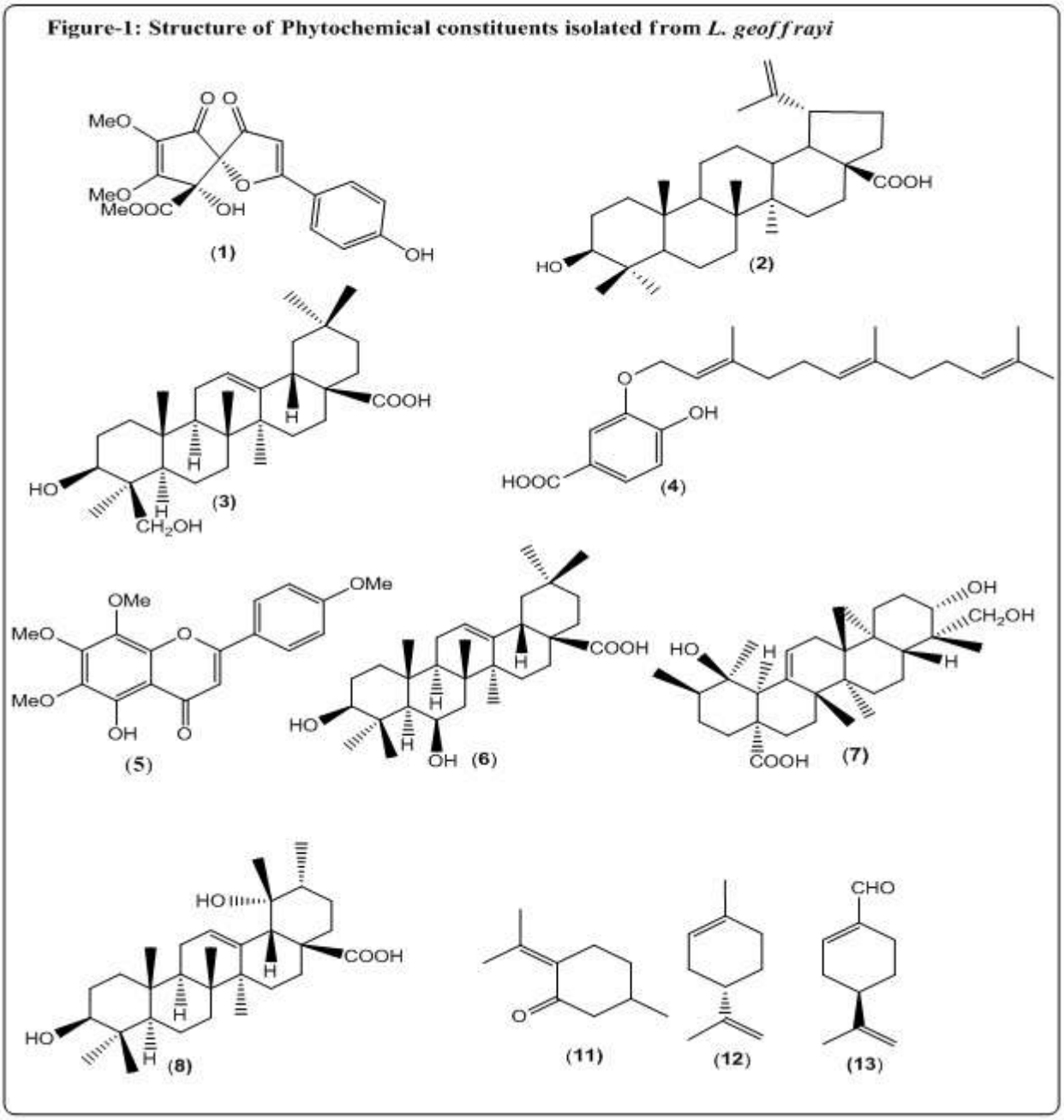
Figure-1: Structure of Phytochemical constituents isolated from *L. geoffrayi*



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